FLUX OF WATER VAPOR IN THE TERRESTRIAL STRATOSPHERE AND IN THE MARTIAN ATMOSPHERE. Conway Leovy, Matthew Hitchman, Dept. of Atmospheric Sciences, University of Washington, Seattle, WA 98195, Daniel McCleese, Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109.

Measurements of terrestrial stratospheric water vapor concentration are reviewed with emphasis on data obtained with the Limb Infrared Monitor of the Stratosphere Experiment on Nimbus 7 (LIMS; Ref. 1). These data clearly show that the equatorial tropopause region is a source of "anti-water" throughout the year. That is, relatively dry air introduced to the stratosphere at the equatorial tropopause is carried upward in the equatorial branch of the zonal mean diabatic circulation to the upper stratosphere. Methane is also introduced at the equatorial tropopause, carried upward in the same stream, and photochemically oxidized in the upper stratosphere to form water vapor which is transported downward into the lower stratosphere in the high latitude branches of the diabatic circulation (Ref. 2). The structure of the important rising branch of this diabatic circuit is controlled and modulated seasonally and interannually by a variety of dynamical processes including Kelvin, and Rossby waves. Details of these controlling mechanisms have also been revealed by LIMS measurements of temperatures and ozone concentrations. LIMS measurements allow diagnosis of the wave structures as well as accurate calculations of the diabatic circulation (Ref. 3). Thus, a single well-focused limb scanning experiment has revealed both the global scale flux of H_2O in the terrestrial stratosphere as well as important features of the natural stratospheric pump driving the flux.

Figs. 1 and 2 illustrate some of these points. A zonal mean water vapor cross section for Jan. 10-15, 1979 shows a dry tongue extending upward from the equatorial tropopause, moister air at high latitudes and evidence for

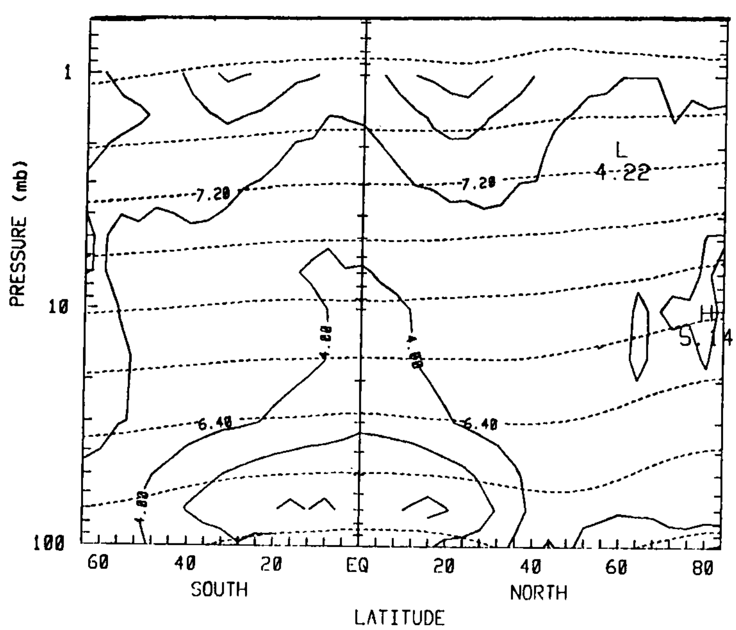

Fig. 1. Zonal mean LIMS water vapor concentration (ppmv) averaged for Jan. 10-15, 1979 superimposed on potential temperature (In(°K), dashed).

moister, possibly subsiding air, between 1 and 3 mb near 30°N and 30°S (Fig. 1). The zonal mean diabatic circulation averaged over Dec. 12-17, 1979 (Fig. 2) exhibits rising and sinking centers near the equator and 30°N and 30°S between 0.5 and 3.0 mb that may have been responsible for water vapor vertical transport over the intervening 28 day period. This complex vertical velocity pattern at low latitudes is due to the pattern of low latitude wave driving (Ref. 3).

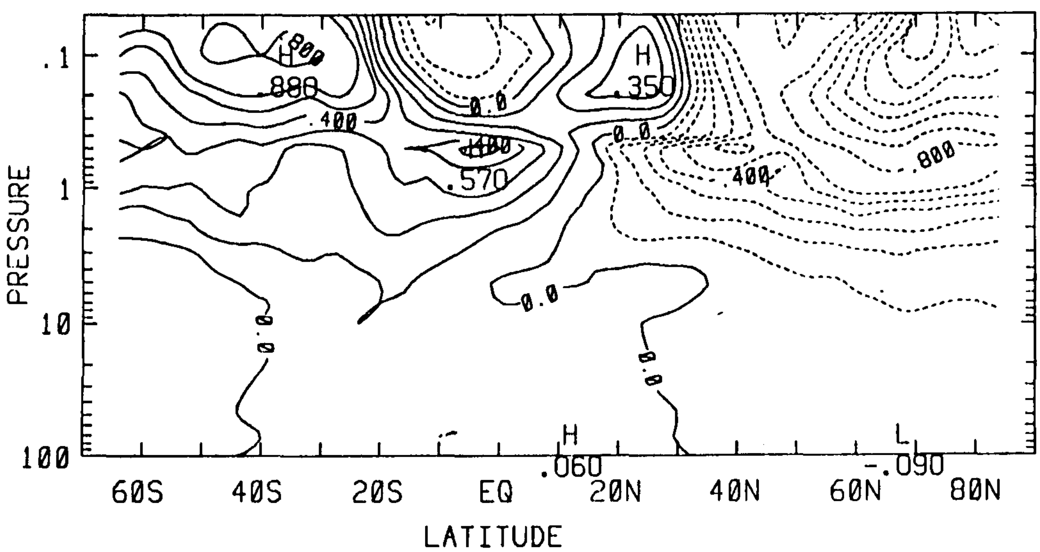

Fig. 2. Zonal mean diabatic circulation deduced from LIMS ($cm\text{-}s^{-1}$) averaged for Dec. 12-17, 1978.

The Pressure Modulator Infrared Radiometer (PMIRR) which is part of the current Mars Orbiter experiment package will be able to make comparable observations of Mars (Ref. 4). It will measure temperature, dust, and water vapor distributions with ½ scale height vertical resolution. The temperature and dust measurements should make it possible to calculate the zonal mean diabatic circulation, and the high vertical resolution should make it possible to identify and characterize Rossby and Kelvin waves. Thus, there is good reason to expect that PMIRR on the Mars Orbiter will lead to an understanding of the atmospheric branch of Mars' water cycle comparable to that achieved for Earth's stratosphere with the aid of the LIMS data.

REFERENCES

1. Remsberg, E., J. M. Russell III, L. L. Gordley, J. C. Gille, and P. L. Bailey, 1984. Implications of the stratospheric water vapor distribution as determined from the Nimbus 7 LIMS experiment. J. Atmos. Sci., 41, 2934-2345.

2. Jones, R. L., and J. A. Pyle, 1984. Observations of CH_4 and N_2O by the Nimbus 7 SAMS: a comparison with in situ data and two dimensional model calculations. J. Geophys. Res., 89, 5263-5279.

3. Hitchman, M., and C. Leovy, 1986. Evolution of the zonal mean state in the equatorial middle atmosphere during October 1978 - May 1979. J. Atmos. Sci., 43, (in press).

4. McCleese, D. J., J. T. Schofield, R. W. Zurek, J. V. Martonchik, R. D. Haskins, D. A. Paige, R. A. West, D. J. Diner, J. R. Locke, M. P. Chrisp, W. Willis, C. B. Leovy, and F. W. Taylor, 1986. Remote sensing of the atmosphere of Mars using infrared pressure modulation and filter radiometry. Applied Optics (in press).